[WITH THE WRITER'S COMPLIMENTS.]

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A REPORT ON THE PERCENTAGE OF NEAR-SIGHT

FOUND TO EXIST IN THE CLASS OF 1880 AT HARVARD COLLEGE, WITH SOME ACCOUNT OF SIMILAR INVESTIGATIONS.

II.

AN ACCOUNT OF THE PHAKOMETER OF SNELLEN.

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A REPORT ON THE PERCENTAGE OF NEAR-SIGHT FOUND TO EXIST IN THE CLASS OF 1880 AT HARVARD COLLEGE, WITH SOME ACCOUNT OF SIMILAR INVESTIGATIONS.

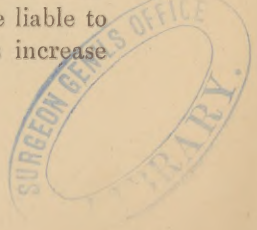
CHARLES W. ELIOT, LL. D., *President of Harvard College:*

SIR, — I present herewith the results of an examination of the eyes of the present freshman class, made in the month of January, 1877, and undertaken with the view of determining the percentage of near-sightedness in the class on entering college as compared with the percentage of near-sight that would be found to exist at the termination of the under-graduate course.

Near-sight, or myopia, is by no means the innocent affection that ordinary text-books on physiology have so long represented it. Perhaps no idea concerning the organ of vision is more firmly grounded in the popular mind than that a near-sighted eye is a *strong* eye, the difficulty depending on an undue convexity of the crystalline lens or of the cornea, and likely to be corrected in after-life by the flattening of one or the other. This is wholly false. Near-sightedness depends on a change in shape, an elongation of the eyeball; its progress, on an increase of that elongation; its dangers, on that elongation being pressed beyond the power of endurance of the tissues of which the organ of sight is composed.

Near-sight is either stationary or progressive. The former variety is, unfortunately, comparatively rare. Having remained at the same point up to about the fortieth year, it may afterwards even slightly decrease, as the crystalline lens flattens and the pupil contracts, thus neutralizing to some extent the unnatural length of the globe.

This state of things is, however, the exception; progression is the rule. The words in which this is described by Donders have, for years, been classical: "When the increase in length of the eye has reached a certain point, its layers become so thin and their power of resistance so much diminished that the stretching process can *no longer remain stationary*, especially as the pressure in the interior of the myopic eye is generally somewhat heightened. The progressive stretching and the progressive myopia go hand in hand, *and here we have a true disease of the eye. I unhesitatingly proclaim a myopic eye to be a diseased eye.* High degrees of myopia are much less likely to remain stationary than slight degrees; even in advanced age they are liable to increase. Nearly all myopia is progressive in the young, its increase



being often coupled with symptoms of irritation. This time of life is the critical one, for the myopic eye; if, during its continuance, the myopia does not appreciably increase, it may become stationary. If, however, it considerably advances, it will ultimately become more difficult to limit its progress. *This is therefore the time when special efforts must be made to guard against injurious influences.* On this point I can hardly lay sufficient stress. Apprehension must be entertained with regard to the future of every case of progressive myopia. For, if it constantly progresses, distressing symptoms soon arise, interfering with the usefulness of the eye. And, not infrequently, at the age of fifty or sixty, *in some cases even earlier*, vision may be irretrievably destroyed. Such an issue may be due to *retinal separation*, to *hæmorrhage*, or finally to *atrophy* (suspension of nutrition) and *degeneration of the macula* (the most sensitive portion of the retina)."

Modern science has fortunately provided the surgeon with a means of accurately measuring and expressing the amount of myopia present in any eye, and has also given him a formula for indicating the amount of vision inherent in that eye when furnished with the glass neutralizing its near-sight. Thus the myopia and the vision being measured and stated in simple figures, a subsequent examination would easily ascertain whether the myopia has progressed or the vision degenerated, and express it in the same simple manner. The difference between the first and second sets of figures would show the extent of the increase, the amount of the degeneration.

Such examinations have, for some years, been made on the continent of Europe, and recently in this country. A brief reference to their results will clearly demonstrate their utility.

The point they illustrate is the progress of myopia, due to the modern system of education.

The end in view is the elimination, as far as possible, of the special exciting cause or causes, when they are once ascertained.

About the year 1867, Dr. Cohn, of Breslau, examined the eyes of 10,060 school children and pupils. His results may be summarized as follows: —

In no village school was myopia found among children who had not yet completed their first half year of work. In these schools, taken as a whole, there was found 1.4 per cent. of myopia.

Taking all schools together, and following the scholars, at successive intervals, from the first half year to the fourteenth year of school life, the percentage of myopia was found to be the following: —

1st Half Year.	2d Half Year to 2d Year.	3d and 4th Years.	5th and 6th Years.	7th and 8th Years.	9th and 10th Years.	11th and 12th Years.	13th and 14th Years.
0.4	4.8	8.6	7.9	11.3	24.1	49.5	63.6

In 1871, Dr. Erismann published the results of his investigations of the condition of the eyes of 4358 scholars at various educational establishments in St. Petersburg. The pupils were aged from eight to twenty. Taking the classes in order, the fifth being the most advanced, the following results were obtained : —

Class.	Percentage of Myopia.	Class.	Percentage of Myopia.
Preparatory.....	13.6	III.....	30.7
I.....	15.8	IV.....	38.4
II.....	22.4	V.....	41.3

In 1874 and 1875, Dr. Conrad examined the eyes of 3036 school children in Königsberg.

He found the percentage of myopia to rise as follows : —

Class.	Percentage of Myopia.	Class.	Percentage of Myopia
VIII. (youngest).....	11.1	IV.....	28.44
VII.....	15.8	III.....	44.39
VI.....	20.5	II.....	54.59
V.....	21.8	I.....	62.10

In 1872, 1873, and 1875, Dr. Reuss examined 1050 pupils at the gymnasia of Vienna.

His results are here shown : —

Class.	Percentage of Myopia.	Class.	Percentage of Myopia.
I.....	33.4	V.....	43.5
II.....	39.4	VI.....	47.7
III.....	47	VII.....	61.4
IV.....	48.2	VIII	59.6

After one year Dr. Reuss found forty-one per cent. of the myopic eyes unchanged, while the difficulty had increased in 47.7 per cent. In the third year 28.4 per cent. only remained unchanged, while sixty-one per cent. had grown more near-sighted.

In 1876, Dr. Pflüger published the result of his investigations in the schools of Lucerne, 1846 pupils being examined.

Myopia was found to be present in the following percentage, according to age : —

Year of Life.	Percentage of Myopia.	Year of Life.	Percentage of Myopia.
7	0	15	26
8	2	16	30
9	3	17	43
10	6	18	55
11	6.5	19	56
12	6	20	40
13	10	21	61.5
14	14.5		

In our own country, Dr. Agnew, of New York, has instituted examinations of the eyes of 1479 school children and advanced pupils in Cincinnati, New York, and Brooklyn. His results were published during the present year. They are as follows : —

CINCINNATI.

School.	Percentage of Myopia.
District	10
Intermediate	14
High	16

NEW YORK COLLEGE.

Class.	Percentage of Myopia.
Introductory	29
Freshman	40
Sophomore	35
Junior	53
Senior	37

BROOKLYN POLYTECHNIC.

Department.	Percentage of Myopia.
Academic	10
Collegiate	28

From the foregoing figures the influence of study on the development and advance of near-sight may readily be appreciated. The facts speak for themselves.

It has occurred to me that by following the same class through its school or collegiate course, and noting the different phases that myopia assumes in the same individual at different periods of his career, results of much practical importance might be attained. A study of the cases where myopia most progressed might add to our knowledge of its cause, and increase our means of prevention.

I commenced in the fall of 1875 with Amherst College, and continued the investigation last autumn. The classes of 1879 and 1880 were required to report to me for examination, and were furnished time for that purpose. Twenty-eight per cent. of the former class were, in the fall of 1875, found to be myopic. One year later fifty per cent. of these had grown more near-sighted. Twenty-seven per cent. of the latter class were found, early in their freshman year, to be myopic.

The kindness of the faculty of Harvard College enabled me to examine volunteers from the class of 1880, in January of the present year. One hundred and twenty-two presented themselves for that purpose. Of these, 29.5 per cent. were found to be myopic.

The accompanying printed forms are filled in with the name and age of each individual, the state of each of his eyes as separately tested by glasses and the ophthalmoscope, the amount of his vision, and remarks on his previous history and family peculiarities in this regard. Blanks are left for a similar examination at the close of the senior year. Only a little over half of the class presented themselves. The percentage of near-sight corresponds to a remarkable degree with that obtained by Dr. Agnew in New York and Brooklyn, and by myself at

Amherst. It is worthy of remark that *twenty-two per cent.* of the near-sighted members of the Harvard class of 1880 had, up to the time of the examination, supposed their vision to be normal.

The advantages of such examinations to the college student are manifest. He is enabled at no further outlay to himself than a trifling expenditure of time and trouble to obtain, at the outset of his collegiate career, important information in regard to the state of his eyes, their availability for study, and the course he must pursue to maintain their integrity or keep existing evils from increasing. At the termination of his under-graduate course he learns the effect of his four years of study, and is thereby enabled to form or modify his future plans; and in after life he can at any time, by consulting the college records, learn to what extent his eyes have varied from the condition they were in, and to what extent his vision has altered from the amount he possessed when he was an under-graduate.

But such examinations, to be reliable and truly valuable, require the attendance of the whole class. And I would respectfully submit to the consideration of the proper authorities whether, in view of the reasons now alleged for making and following up such investigations, it may not be found expedient to insist on every member of the freshman class passing this trifling ordeal on the occasion of his admission to college, and on his submitting to it once more just previous to the termination of his senior year.

I would here express my deep obligation to Professor Wolcott Gibbs, who took pains to arrange his lecture room and laboratory for my examinations, and placed them for several days at my disposal at considerable inconvenience to himself. Also to Dr. Wm. S. Dennett, of Boston, who materially lightened my labors by undertaking the ophthalmoscopic examination of every case, and furnished me with two hundred and forty-four (244) separate estimates of refraction.

In conclusion I would direct the attention of the faculty to the following points: First. Myopia is probably not, as commonly supposed, congenital. It is admitted that a tendency to the disease may be and is frequently inherited. Second, it has been shown by the very numerous examinations above cited that it occurs among school children at first in a very small proportion of the whole number, and that it increases with the course of study till, in many cases, not less than sixty per cent. of the graduates of European colleges and high schools are found to be myopic.

It is only by a most careful and thorough study of the disease, as prevalent in schools and colleges, that we can hope to devise means of preventing its extension and its progress in individuals.

[Note. As an appendix to the foregoing, I will briefly report a case that illustrates two points I have alluded to: first, the development of

myopia in a person born emmetropic, but inheriting strong tendencies in the direction of near-sight; second, the rapid and alarming progress of unchecked myopia.

March 11, 1868. Saw this day for the first time Master M., aged ten. His father is quite near-sighted, and has for many years used concave glasses, what number I am unable to ascertain. His mother has in the right eye a myopia of 5.75 dioptrics, left M. 4.5. The lad himself has *right* emmetropia, *left* M. 0.75. Interni strong; each fundus normal. He comes for slight asthenopic symptoms, and the refraction is merely noted incidentally. Vision of each eye normal.

November 1, 1870, M. 0.75 in each eye.

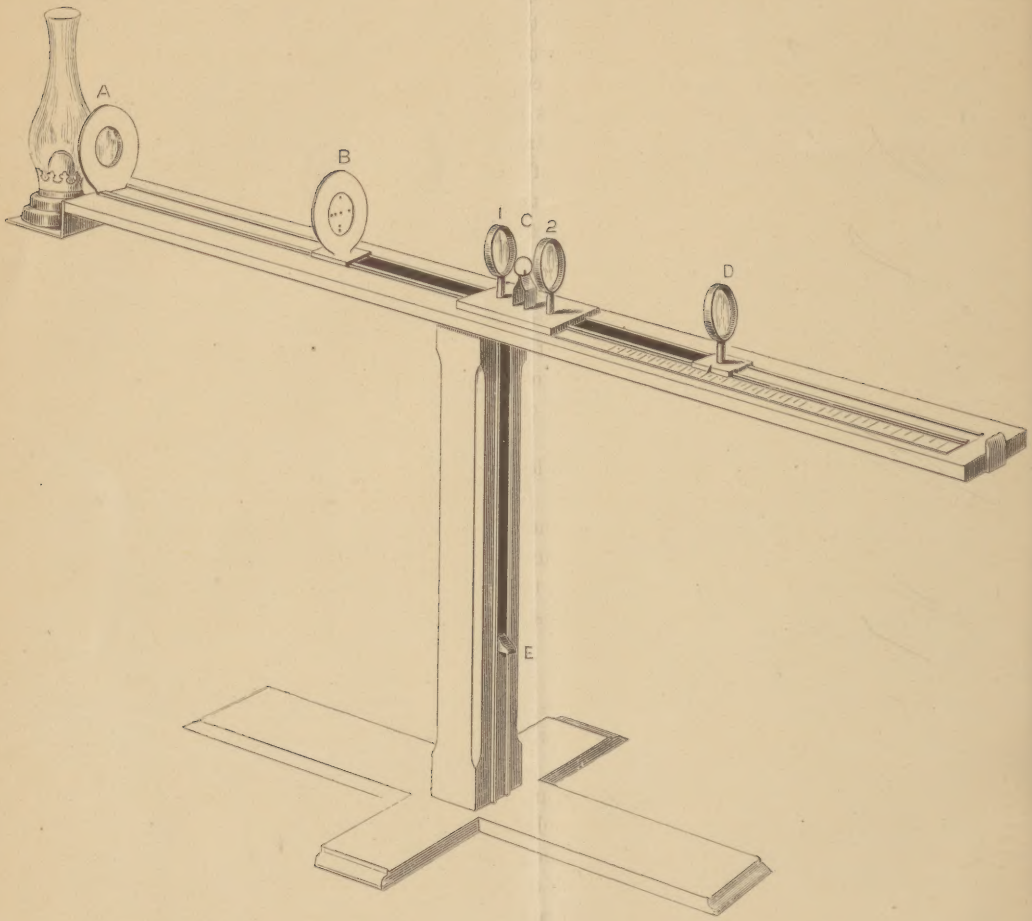
June 20, 1873, *right* M. 2.25, *left* M. 2.75. Patient is on his way to Europe. A course of atropine treatment is advised on his return in the fall.

I now lost sight of him for more than two years, during which time he was preparing himself for the examination to enter college. November 26, 1875, I found M. 4.50 in each eye, also in each a progressive posterior staphyloma. Atropine treatment and entire rest were again earnestly advised, but not concurred in by the parents.

The course of study has, notwithstanding all this, been steadily persevered in. At his last visit, March 1, 1877, Mr. M. had M. 5.50 in each eye by sight-test and ophthalmoscope, and each staphyloma was becoming marked. No suggestions with regard to rest or treatment were heeded.

Here is a progressive change, ranging in nine years from emmetropia in one eye and M. 0.75 in the other to M. 5.50 in each (M. $\frac{1}{4\frac{1}{8}}$ to M. $\frac{1}{7}$ of the former series). I suppose it would have been perfectly possible to have arrested the myopia at any time during this period; in the outset, indeed, to have prevented it altogether. If the present use of the eyes be persisted in, the preparation for college completed, and college itself passed through, the chances are that the myopia will go on increasing, and possibly an amount of structural change be brought about incompatible with the integrity of the eye through life.]

BOSTON, *February* 28, 1877.


A
B
1
C
2
D
E

THE PHAKOMETER, FOR THE DETERMINATION OF THE FOCUS AND CENTRE OF SPECTACLE LENSES.[1]

In this little pamphlet Dr. Snellen, of Utrecht, gives us a description of a new and ingenious instrument he has contrived for the above purpose. The accompanying wood-cut is copied from the one given by him.

The new numeration of spectacle lenses consequent on the introduction of the metric system is rapidly winning its way into favor in this country, and daily gaining adherents. The ophthalmic surgeon, adapting and working with metric glasses, abundantly realizes the truth of the claim made by Donders at Heidelberg in 1875, that this system would be found the most convenient, the quickest of application, and the most exact. A few months' experience with it brings a vivid sense of the difficulties and complexities of the old inch scale.

At first the glasses of the former trial-case had to be used, their metric values being ascertained by means of the table published by Snellen and appended to his "Optotypi," or test types. Subsequently, Roulot, Nachet, and Crétès, of Paris, began to furnish trial-cases of glasses, ground according to the new scale. Such glasses, in the possession of the surgeon, would serve as standards with which to compare the ordinary lenses of commerce.

For an accurate determination, however, we must have an accurate standard. This is particularly necessary at the present time, when the tools by which glasses are fashioned are undergoing a change of shape to correspond with the new required numbers. The old standards have to be discarded and new ones provided.

The strength of a convex standard lens can be found directly by allowing parallel rays, falling upon it along the line of its principal axis, to form an image on a screen placed behind it, the distance between the lens and the image being its focal length. In practice this method can be successfully employed only with the stronger lenses, the weaker forming a diffuse and faint image at a more or less considerable distance, rendering accuracy of measurement very difficult.

Donders has described a method of measuring the strength of a lens by means of the ophthalmometer. There are certain difficulties in the way of applying this method, not the least of which is the fact that an ophthalmometer is possessed by comparatively few.

Dr. Snellen has recently invented an instrument by means of which the metric strength of any convex lens, spherical or cylindrical, can be immediately and accurately read off, and at the same time its centre determined. It is called a "phakometer," and is based on the principle that when an object and its image formed by a convex lens are of equal size, object and image are equidistant from the lens, and such distance is twice the focal length of the lens.

In describing the instrument I will, as far as possible, follow Dr. Snellen's own words. A reference to the wood-cut will render the explanation easy to follow. The luminous object (B) and the screen (D) on which the object is formed are moved by the same mechanism, being simultaneously moved

[1] *De Phakometer, ter bepaling van focus en centrum van brilglazen.* Door Dr. Herman Snellen.

towards or made to recede from the lens, placed midway between them, at an equal rate. Each is affixed to the extremity of a thin, very flexible, steel ribbon, running along the track on which object and screen move, and descending side by side into the upright on which the track or flooring of the instrument is supported. Passing down this upright support they are secured each to the same movable button (E). Pushing the button upwards causes the distal extremities of the steel band to pass in opposite directions along the track; pulling it down brings them again nearly together in its centre, followed of course by the object and the screen.

The luminous object consists of a black metal screen pierced with several fine openings arranged in the form of a cross, and covered with ground glass. It is illumined by parallel rays proceeding from a lamp placed in the focus of a lens (A), and on a projecting shelf attached to the phakometer. The screen on which the image is formed consists of ground glass, and has on it black dots, corresponding accurately to the little openings on the screen but of course in reversed position.

The lens to be examined is held in a clip (C) consisting of two metallic rings placed in the centre of the apparatus, midway between the luminous object and the screen. One of these rings has an upright spur projecting from it, designed to point out the true centre of the lens under examination. An auxiliary lens of 2.75 dioptrics is placed on either side of the clip (represented by 1 and 2 on the diagram). The distance between these lenses is fifty millimeters.

The whole length of the apparatus is eighty-six centimeters, its height fifty-three centimeters. The luminous object and the screen can be separated 777.94 millimeters from each other. At this distance a sharp image of the luminous points is formed on the screen, and here the zero point of the scale begins. This scale is engraved on a strip of metal, running parallel to the track along which the screen moves. Its divisions correspond with the metric lenses from 0.25 up to twenty. A small pointer projects from the screen for the purpose of denoting the division of the scale opposite which it stops.

The lens the value of which is to be ascertained is placed in the central clip, and object and screen are moved from or brought toward each other until a sharp image of the luminous points is formed on the screen. The division of the scale opposite the point of arrest of the screen shows the value of the lens in dioptrics. If the luminous points do not exactly coincide with the dots on the screen, already described, the lens is improperly centred, and must be moved until correspondence is secured. The true centre of the lens is then indicated by the pointer attached to the clip.

The values of cylindrical lenses can easily be found in like manner, lines instead of points being formed on the screen. Approximate determinations of concave spherical and cylindrical lenses can also be made by combining them with stronger convex glasses. Lenses with one face spherical and one cylindrical can be analyzed easily and with considerable correctness. Absolute accuracy can however only be predicated of symmetrical biconvex lenses for which the scale is meant. For these the instrument will be found correct within 0.05 of a dioptric, a lens having a focal length of twenty meters.

The advantages of the phakometer may be briefly summarized: First and foremost it establishes the accuracy or want of accuracy of our new test lenses. Further, it enables us to convert our former inch glasses into dioptrics, tells us what dioptric a patient is wearing, and informs us whether the optician has furnished the glass designated in our prescription; all this more rapidly, easily, and correctly than by the old method of comparison. Finally, we discover whether glasses are properly centred.

In connection with this account of the instrument I have been urged to publish the results of my examination of Nachet's trial-case of metric glasses, and to give the errors I found. These measurements were made with the utmost care, and repeated several times.

SPHERICAL.

No. of Dioptric.	Error.	No. of Dioptric.	Error.
0.25	0	5.50	0
0.50	0	6	0
0.75	0	7	0
1	0	8	0
1.25	0	9	0
1.50	0	10	+0.15
1.75	0		
2	0	11	0
2.25	0	12	0
2.50	0	13	0
2.75	—0.05	14	0
3	0	15	0
3.50	0	16	—0.27
4	0	18	—0.22
4.50	0	20	—0.12
5	0		

CYLINDRICAL.

No. of Dioptric.	Error.	No. of Dioptric.	Error.
0.25	0	2.75	0
0.50	0	3	0
0.75	0	3.50	+0.12
1	+0.05	4	0
1.25	+0.05	4.50	+0.05
1.50	+0.15	5	0
1.75	+0.20	5.50	0
2	+0.15	6	0
2.25	0	7	+0.15
2.50	+0.1		

[NOTE. I am under much obligation to Dr. Charles H. Williams, of Boston, who was kind enough to lend me his phakometer while I was awaiting the arrival of my own.]